of iron increases at higher temperatures in a greater ratio than that of platina. The discrepancy between the temperatures derived from the observations with his first pyrometer and the present one, he admits to be considerable, but believes they may be sufficiently accounted for by the differences in the circumstances of the experiments, without imputing inaccuracy to the instrument. The author next attempted to ascertain the effects of the most intense heat which it was possible to produce in a furnace, and to measure the utmost limits of expansion in a platina bar; but various circumstances interfered with the success of these experiments, which afforded, however, many curious results as to changes of integration in platina by the effects of heat.—The paper concludes with some observations on the practical advantages possessed by the present instrument.

On the Phenomena and Laws of Elliptic Polarization, as exhibited in the Action of Metals upon Light. By David Brewster, *LL.D. F.R.S. L. & E.* Read April 22, 1830. [*Phil. Trans.* 1830, *p.* 287.]

The action of metals upon light has always presented a remarkable, and hitherto inexplicable, anomaly in the science of polarization. Malus, to whom this branch of optics owes its origin, had at first announced that metals exerted no polarizing influence on light; but Dr. Brewster, by employing a different method of observation, ascertained that the light reflected from metallic surfaces was modified in such a manner as to exhibit, when transmitted through thin crystallized plates, the complementary colours of polarized light. He afterwards discovered the curious property possessed by silver and gold, of dividing a polarized ray into complementary colours by successive reflexions. M. Biot, to whom the author communicated this discovery, pursued the inquiry to which it led, and arrived at the same conclusions as to the mode in which this class of phenomena should be explained. Subsequent researches, however, convinced the author that these generalizations had been too hastily formed; and the study of Fresnel's curious discoveries respecting circular polarization enabled him to advance still further in the inquiry, and he now presents to the Royal Society in this paper, a complete analysis of the singular phenomena exhibited in the action of metals upon light.

The first section of the paper treats of the action of metals upon common light. A ray of common light reflected from a metallic surface when analysed by a rhomb of calcareous spar, exhibits a defalcation of light in one of the images, as if a portion of the light was polarized in the plane of reflexion. This effect will be still more distinctly seen on examining the system of polarized rings formed round the axes of crystals by means of the light reflected from metals. If the light had s..ffered no modification by reflexion, or if the metal reflected in equal quantities the light polarized in opposite planes, the rings would not be visible at all, whereas it is found that they are easily visible in the light reflected from all metals. They are most distinctly perceived at an incidence of about 74°, and be-

come more and more faint as the incidence succeeds or falls short of that angle. They appear best defined in light reflected from galena, and from metallic lead, and with least distinctness in light reflected from silver and gold. On examining the effect of successive reflexion of the same ray by metallic surfaces, the author found that the quantity of light which each polarizes in the plane of reflexion, increases with every reflexion, and that in several cases the whole incident pencil is completely polarized.

The action of metals upon polarized light forms the subject of the second section of this paper, in which he investigates the changes which polarized light undergoes, according as it is reflected at different angles of incidence, and in different azimuths of the plane of incidence with relation to the plane of primitive polarization. The light experiences in these cases a physical change of a nature intermediate between that of completely polarized light, and light wholly unpolarized, neither does it possess the same characters as that which has passed through thin crystallized plates. Its constitution is exceedingly analogous to light which is circularly polarized; that is, which comports itself as if it revolved with a circular motion during its transmission through particular media. But in the case of circular polarization, the ray has the same properties in all its sides, and the angles of reflexion at which it is restored to simple polarized light in different azimuths, are all equal, like the radii of a circle described round the ray. In the case of metallic reflexions, the new phenomena discovered by Dr. Brewster may be designated by the term *elliptic polarization*, because the angles of reflexion at which this kind of light is restored to polarized light may be represented by the variable radius of an ellipse. In circular polarization the restored ray has its plane of polarization always inclined — 45° to the plane of the second system of reflexion. In elliptic polarization, the inclination of the plane of the restored pencil is always less than 45°. In the former case, this plane continues by successive reflexions to oscillate on each side of the plane of reflexion, with a never-varying amplitude, from + 45° to — 45°; while in the latter case the same plane oscillates with an amplitude continually diminishing till it is brought to zero in the plane of reflexion. In steel, the polarization is highly elliptical, and the amplitude of the oscillations of the plane of restoration is quickly brought to zero; but in silver, whose polarization approaches nearly to circular, the oscillations diminish very slowly in amplitude. The peculiar character of elliptic polarization shows itself also in another manner in the variable position of the ellipses which regulate its angles of restoration upon steel.

In the third section of his paper, the author treats of the complementary colours produced by successive reflexion from the polished surfaces of metals.

He concludes by observing, that although we do not understand the nature of the forces by which metals reflect the two oppositely polarized pencils, yet we are certain they do not act exactly in the same manner as the second surfaces of transparent bodies, when pro-

ducing total reflexion. Setting out from a perpendicular incidence, the least refrangible rays begin to suffer the double reflexion sooner than the mean ray, and they sooner reach their maximum of elliptic polarization, thus exhibiting the inversion of the spectrum. The theory of circular polarization, as given by Fresnel, will no doubt embrace the phenomena of elliptic polarization; and when the nature of metallic action shall be more thoroughly examined, we may expect to be able to trace the phenomena under consideration to their true source.

Researches in Physical Astronomy. By John William Lubbock, *Esq. F.R.S.* Read April 29, 1830. [*Phil. Trans.* 1830, *p.* 327.]

The analytic expressions for the variations of the elliptic constants given by Laplace in his *Mécanique Céleste*, are true only when the square and higher powers of the disturbing forces are neglected in the computation; and by proceeding on the supposition that all the planets move in circular orbits and in the same direction, he has demonstrated that the eccentricities and inclinations vary within small limits, and that the stability of the planetary system is always eventually preserved. But Mr. Lubbock shows in the present paper that these conditions are not necessary to the stability of a system of bodies subject to the law of attraction which governs our system; and he gives expressions for the variations of the elliptic constants which are rigorously true, whatever power of the disturbing force be retained.

On the Error in Standards of Linear Measure, arising from the thickness of the Bar on which they are traced. By Captain Henry Kater, *V.P. and Treas. R.S.* Read June 17, 1830. [*Phil. Trans.* 1830, *p.* 359.]

While engaged in the adjustment and verification of the copies of the Imperial standard yard destined for the Exchequer, Guildhall, Dublin, and Edinburgh, the author discovered a source of error arising from the thickness of the bar, upon the surface of which measures of linear dimension are traced. A notice to that effect was published in the Philosophical Transactions for 1826; and the object of the present paper is to give an account of the experiments the author has since made on this subject, and to describe a scale which he has had constructed, so as almost entirely to obviate the source of error thus introduced.

From the experiments detailed in the first part of the paper, the following conclusions are deduced:—First, that in a standard of linear measure, traced upon the surface of a bar, an error arises from the thickness of the bar when it is placed upon a table the surface of which is not plane; Secondly, that this error in bars of the same material, and of unequal thickness, is within certain limits as the thickness of the bar, and depends upon the extension of that sur-